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(12) **DESCRIPTION OF INVENTION**
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(73) Combined Scientific-Technical Association for Subterranean Electricity Production Procedures and Technology Development.
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(54) **A METHOD FOR COAL BED PROCESSING AND THE EQUIPMENT FOR ITS IMPLEMENTATION**

(57) Utilization: This invention deals with the mining industry, and may be utilized with subsurface and with open development of coal deposits. The essence of the invention: the coal beds are processed by columns or through holes by combustion and gasification of coal inside the bed, with the properly purified and electrochemically processed products of gasification being converted into electricity by means of a fuel cell battery; the oxidation product of hydrogen – one of the main components of the fuel mixture (the coal gasification product)- namely water, is converted within the waste-heat boiler into steam by afterburning of residual fuel, remaining after processing in the fuel cell battery; this steam, together with the inert carbon dioxide – produced by oxidation of the carbon monoxide of the fuel mix – is fed into the combustion zone of the coal within the bed, and the regenerated hydrogen and carbon monoxide are aging fed to the fuel cell battery. 2 pages, 3 claims, 2 illustrations.

This invention deals with the mining industry, and may be utilized with subsurface and with open development of coal deposits.

Purpose of this invention – lower processing costs and decreased levels of environmental contamination by lowering the emission of inert carbon dioxide and other harmful components into the atmosphere.

Fig. 1 shows the proposed coal bed processing technology by columns, where: 1, 2 – preparatory mine openings (drifts and cross-sectional trenches); 3 – main mine opening (slope, crosscut, exit trench, etc.); 4 – wells in the bed; 5- perforated well piping; 6- sealing (isolating) walls; 7, 8 – input and output gas piping; 9 – steam piping; 10 – smoke exhaust-commutator device; 11 – blower fan; 12 – apparatus for preliminary purification and processing of the fuel mix; 13 – fuel cell battery; 14 – the waste-heat boiler. Fig. 2 shows the proposed coal bed processing technology by holes, i.e. where the bed is prepared through one mine opening (drift, adit, or cross-sectional trench), including the same items as Fig. 1, identified by the same numbers. Additionally, Item 15 on Fig. 2 shows the auxiliary well along the bed, placed at a certain (predetermined) distance from the preparatory opening 2, perpendicularly to wells 4.

The proposed coal bed processing technology is carried out in the following manner.

Example 1. Suppose we need to process a coal bed that is prepared by two sectional mine openings 1 and 2 and one main mine opening 3. Between the preparatory openings 1 and 2, wells 4 are drilled into the bed at predetermined distance (approximately 10-15 m) between each other, and perforated piping 5 is put into the wells. The edge sections of the coal bed, extending beyond drifts 1 and 2, are removed and sealing barriers 6 are installed to isolate the coal bed (Fig. 1).

Perforated well piping 5 is inserted through the sealing barriers (walls) 6 onto drifts 1 and 2, where they are connected to the input and output gas piping 7 and 8 and to the steam piping 9, accordingly. On drift 2, the perforated well piping 5 is connected to pipes 7 and 8 in an alternating fashion, e.g. pipes (4) /sic/ from even wells are connected to pipe 7 and from odd wells to pipe 8. On drift 1, all piping (4) /sic/ is connected to the steam piping 9.

The smoke exhaust-commutator device 10, blower fan 11, apparatus for preliminary purification and processing of the fuel mix 12, fuel cell battery 13, and the waste-heat boiler 14 are installed at the mail mine opening 3. The input and output gas pipes 7 and 8, blower fan 11, and apparatus for preliminary purification and processing of the fuel mix 12 are connected to the smoke exhaust-commutator device 10, and its output is connected to the input of the fuel cell battery 13. The output of the fuel cell battery 13 is connected to the combustion chamber and input of the waste-heat boiler 14 steam generator. The steam pipe 9 and one of the inputs of the smoke exhaust-commutator device 10 are connected to the latter. After installing the main equipment on a predetermined column length, the coal bed is ignited by some means from the side of drift 1 and blower 11 supplies air for coal combustion and gasification through piping 7 to the even wells 4, while the smoke exhaust-commutator device 10 exhausts (removes) through the odd wells the coal gasification products, containing carbon monoxide (CO) and hydrogen (H_2), as the main combustible components, and a certain amount of filler compounds (carbon dioxide, nitrogen, etc.)

This fuel mixture is fed to the apparatus for preliminary purification and processing 12 and thereafter to the fuel cell battery 13, where hydrogen and carbon monoxide are converted by electrochemical means into electricity that is supplied to consumers. The residual fuel mixture and water from the fuel cell battery 13 are supplied to the combustion chamber and the steam generator, respectively, of the waste-heat boiler 14, where afterburning of the fuel mixture produces steam. Then, the gaseous exhaust of the waste-heat boiler 14 combustion chamber, containing mainly inert carbon dioxide (CO_2), and the steam from the steam generator, and also the carbon dioxide generated in the fuel cell battery by oxidation of carbon monoxide are again fed to the active (high-temperature) zone of coal gasification within the bed, where the inert carbon dioxide is reduced by coal to combustible carbon monoxide and the water vapor is endothermically decomposed into hydrogen and oxygen. In this case the steam from the steam generator is supplied through steam piping 9 and is fed by the perforated piping 5 into the coal oxidation (combustion) zone of those wells that are at this time in air-supply mode. Considering that the outlet of the waste-heat boiler 14 combustion chamber is connected to one of the inputs of the smoke exhaust-commutator device 10 together with blower fan 11, it is evident that the inert carbon dioxide is not emitted, as usual, into the atmosphere, but rather is fed together with the air supply into the coal gasification zone within the bed.

Therefore, as the coal bed is being consumed with concurrent production of electricity by electrochemical means by utilizing the fuel cell battery 13, the elements of the fuel mixture (carbon monoxide and hydrogen) are continuously regenerated within the coal gasification zone. While improving the efficiency of coal utilization, as a primary energy source, this process also solves an even more important problem, namely improving the ecological cleanliness of producing electrical energy, since emission of inert carbon dioxide into the atmosphere is by this process practically eliminated. To assure efficient consumption of the bed entirely by coal gasification in the pillars between wells, with concurrent regeneration of the fuel mixture elements, the supply of air and the exhaust of the coal gasification and fuel mixture component regeneration products are switched as needed from one part of the wells to the other with the help of the smoke exhaust-commutator device 10. As some wells are fully processed, they are disconnected from pipes 7 and 8 and from steam piping 9 and new wells are put into operation. The total number of wells in operation is determined by the capacity of the equipment, by the required energy output, etc.

Example 2. Suppose we need to process a coal bed that is prepared only by one sectional mine opening 2 (drift, adit, or cross-sectional trench). As in the previous example, wells are drilled from opening 2 into the bed at a certain distance between each other. Perforated pipes (5) are inserted into wells 4, and the edge section of the coal bed, extending beyond drift 2, is removed and a sealing barrier (wall) 6 is installed. Input and output gas piping 7 and 8 is installed along drift 2, and the same equipment, as in the previous example, is installed at the main well opening 3. The difference is that in this case the outlet of the waste-heat boiler 14 combustion chamber and the outlet of its steam generator are connected to the inlet of the smoke exhaust-commutator device 10.

Also, an auxiliary well or opening is drilled (installed) from the mine opening 3 at a distance from drift 2, equal to the length of the wells 4. The perforated well piping 5 is also connected to pipes 7 and 8 in alternating manner. The coal bed is then ignited at the ends of

wells 4, using auxiliary well 15 for this purpose. Air for gasification of pillars between the wells is supplied through pipe 7 and pipe 8 is used to remove the fuel mixture, which is fed through the smoke exhaust-commutator device 10 to the apparatus for preliminary purification and processing 12 and thereafter to the fuel cell battery 13, where hydrogen and carbon monoxide are converted by electrochemical means into electricity that is supplied to consumers.

The residual fuel mixture and the oxidation products of carbon monoxide and hydrogen from the fuel cell battery 13 are supplied to the combustion chamber and the steam generator, respectively, of the waste-heat boiler 14, where afterburning of the fuel mixture produces steam. The combustion products of the waste-heat boiler 14 combustion chamber, containing mainly inert carbon dioxide (CO_2), and the steam from the steam generator are fed to the inlet of the smoke exhaust-commutator device 10, which is also supplied by air, oxygen, etc. by blower 11. Therefore the spent components of the fuel mixture again enter the high-temperature coal oxidation (combustion and gasification) zone within the bed, where the heat causes endothermic decomposition of water (steam) into hydrogen and oxygen, and the carbon dioxide is reduced by coal to carbon monoxide, i.e. the spent components of the fuel mixture are regenerated (reduced). The regenerated products of the fuel mixture, combined with the products of the actual coal gasification within the bed, are fed in the aforementioned manner back to the fuel cell battery 13, and the bed consumption process in all other aspects remains as in the previous example.

The proposed equipment for implementing the described technology of coal beds processing includes perforated well piping 5, conducted to the preparatory mine openings through sealing (isolating) walls 6 with the necessary seals, and also the input and output gas piping 7, 8 and steam piping 9, installed along the mine openings 1-3. The proposed equipment also includes the smoke exhaust-commutator device 10, blower fan 11, the apparatus for preliminary purification and processing of the fuel mixture 12, fuel cell battery 13, and the waste-heat boiler 14.

The perforated well piping 5 are connected to the input and output gas piping 7, 8 in an alternating manner and the latter are connected to the smoke exhaust-commutator device 10, to which are connected the blower fan 11 and the apparatus for preliminary purification and processing 12, the output of which is fed to the inlet of the fuel cell battery 13. The outlets of the fuel cell battery 13 are connected to the combustion chamber and the inlet of the waste-heat boiler 14, the outlets of which, in turn, are connected accordingly to the well piping 5 and the inlet of the smoke exhaust-commutator 10 (Fig. 1), or simultaneously to the inlets of the latter (Fig. 2).

The operation of the proposed equipment for coal bed processing is described in detail above, while describing the application examples for the proposed technology (Examples 1 and 2) and requires no further explanation.

As a whole, the proposed method for coal bed processing and the equipment for its implementation provide an effective, operator-free, and ecologically clean technology, radically different from the current state of the art, and based upon the electrochemical conversion of coal gasification products and upon continuous regeneration of the spent components of the fuel

mixture into hydrogen and carbon monoxide directly within the coal deposit, i.e. within the coal bed.

CLAIMS

1. A method for coal bed processing, including the uncovering and preparation of the coal beds by capital or sectional, subsurface or open mining, drilling of holes along the bed from the preparatory openings, ignition of the coal bed, supplying air for coal combustion and gasification in the presence of steam, and the exhaust of the coal gasification products through piping installed in the wells along the bed, being different in that, to decrease the operating costs and to improve the ecological cleanliness of the production by decreasing the emission of inert carbon dioxide and other hazardous components into the atmosphere, the in-bed coal gasification products are purified, the fuel mixture is prepared and fed to the fuel cell battery, where the said mixture is converted into electrical energy; the residual fuel and the carbon dioxide produced by oxidation of carbon monoxide, and the water produced by oxidation of the hydrogen in the fuel mixture are fed accordingly to the combustion chamber for afterburning and to the waste-heat boiler's steam generator; the steam and the gaseous afterburning products of the residual fuel, containing carbon dioxide are then fed from the waste-heat boiler through the piping in the well along the bed into the coal combustion zone, where hydrogen and carbon monoxide are regenerated; the regenerated hydrogen and carbon monoxide, together with the coal gasification products are again returned to the fuel cell battery.

2. A method according to Par. 1, being different in that the gaseous products from the waste-heat boiler's combustion chamber are fed together with the blown-in air for coal combustion and gasification from the side of the pillars currently in process.

3. A method according to Par. 1 and 2, being different in that, when a coal bed is processed in columnar fashion, the steam from the waste-heat boiler's steam generator is supplied into the coal combustion zone from the side of the consumed and de-gassed space, but when the bed processing is accomplished through holes, the steam is supplied together with the blown-in air the side of the pillars currently in process.

4. A set of equipment for coal bed processing, including input and output gas piping, well piping, and a waste-heat boiler with a combustion chamber and steam generator, being different in that, to decrease the operating costs and to improve the ecological cleanliness of the production by decreasing the emission of inert carbon dioxide and other hazardous components into the atmosphere, the installation is equipped with a fuel cell battery, an apparatus for preliminary purification and processing of the fuel mixture, and a smoke exhaust-commutator; the fuel cell batteries are connected through the apparatus for preliminary purification and processing of the fuel mixture and the smoke exhaust-commutator to the input and output gas piping, and the outlets of the fuel cell batteries are connected to the waste-heat boiler's combustion chamber and steam generator, the output of which is either separated and supplied accordingly to the inlet of the smoke exhaust-commutator device and the perforated well piping, or together to the inlets of the smoke exhaust-commutator device, while the blower fan is connected to one of the inlets of the smoke exhaust-commutator device.

Fig. 1

Fig. 2.

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